Semantic Segmentation with Generative Models: Semi-Supervised Learning and Strong Out-of-Domain Generalization

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Abstract

Training deep networks with limited labeled data while achieving a strong generalization ability is key in the quest to reduce human annotation efforts. This is the goal of semi-supervised learning, which exploits more widely available unlabeled data to complement small labeled data sets. In this paper, we propose a novel framework for discriminative pixel-level tasks using a generative model of both images and labels. Concretely, we learn a generative adversarial network that captures the joint image-label distribution and is trained efficiently using a large set of un-labeled images supplemented with only few labeled ones. We build our architecture on top of StyleGAN2 [45], augmented with a label synthesis branch. Image labeling at test time is achieved by first embedding the target image into the joint latent space via an encoder network and test-time optimization, and then generating the label from the inferred embedding. We evaluate our approach in two important domains: medical image segmentation and part-based face segmentation. We demonstrate strong in-domain performance compared to several baselines, and are the first to showcase extreme out-of-domain generalization, such as transferring from CT to MRI in medical imaging, and photographs of real faces to paintings, sculptures, and even cartoons and animal faces. Project Page: https://nv-tlabs.github.io/semanticGAN/